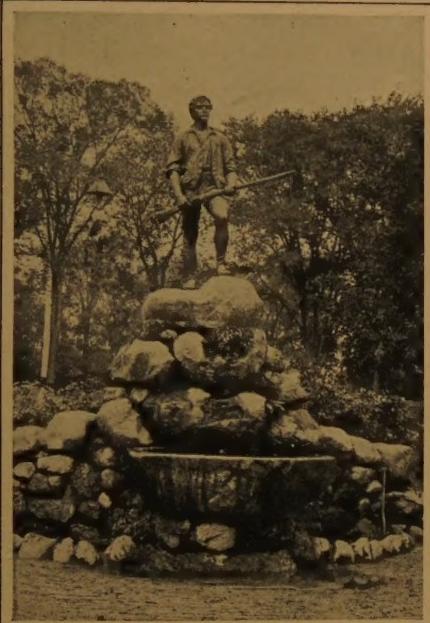


THE STORY OF THE AMERICAN ARMY

By ALBERT BUSHNELL HART
Professor of Government, Harvard University



MENTOR GRAVURES



THE MINUTE MAN

The first fighter for American freedom. The monument in Lexington, Mass. Designed by Henry H. Kitson, and unveiled April, 19, 1900

WASHINGTON TAKING COMMAND OF
THE ARMY

VALLEY FORGE—BARON STEUBEN DRILLING
THE TROOPS

WASHINGTON'S HEADQUARTERS AT NEWBURGH

BATTLE OF GETTYSBURG

THE COLORS AT WEST POINT

THE ARMY ON A HIKE



EDITORIAL NOTE—This is the Story of the Army as an organization. The stories of the great army leaders and of their achievements in military history will be told in later numbers of *The Mentor*.



HERE is a body of men of continuous existence, which goes on while administrations change, and statesmen and generals pass away. This body of men is the Army. The "American Army," since June, 1775, has, without cessation, been wearing the uniform, saluting the flag, and defending the existence of the United States of America. In point of fact the country all this time has been defended by two United States armies. The first is a small permanent force, which is a part of the organized Federal Government, with officers, non-commissioned officers and enlisted men, with traditions, and history, with etiquette, and *esprit du corps*.* The other is made up of the millions of able-bodied men who join local regiments, and who may be called on at any time to serve or to save their country in war. They are the militia, large numbers of whom have in all significant wars served with the regulars.

* Pronounced es-spree-duh-core and meaning "spirit of the organization."

THE STORY OF THE AMERICAN ARMY

Colonial Armies

The first "American army" was a disorderly and whooping band of savages, such as those to whom Champlain taught the superiority of powder and ball over bows and arrows. Next came the early colonial fighters. These tumultuous bands of citizen soldiers were uniformed only in the buckskins of the forest, and knew no discipline except the relentless frontier dangers, which compelled every man to know how to shoot, for the protection of himself and his family. They fought in irregular bands against the Indians, the Spaniards, the French,—and the French and Indians, when "Braddock's army was done so brown."

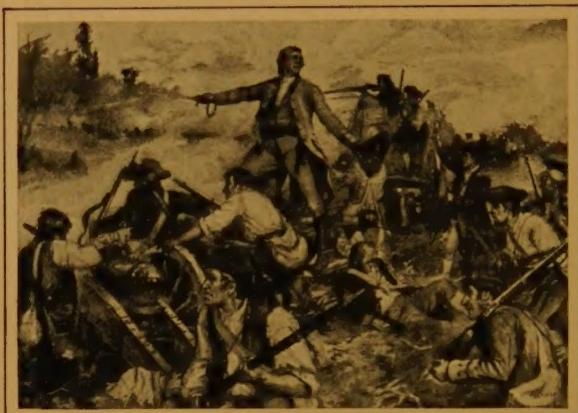
Major George Washington served with the militia in these frontier campaigns, and bitterly complained that "They are obstinate, self-willed, perverse, of little or no service to the people, and very burthensome to the country. Every mean individual has his own crude notions of things, and must undertake to direct. If his advice is neglected, he thinks himself slighted, abused and injured; and, to redress his wrongs, will depart to his home."

The British regiments, with their trained officers, were the forerunners of our later regular army; but they have left in history only one world event, the defeat of the French by Wolfe under the walls of Quebec in 1759. That achievement is fairly matched by the capture of Louisburg in 1744 by the tumultuous New England military and naval force under

Pepperell. Strictly speaking, before the Revolution there never was a genuine American army of trained soldiers, under experienced officers, who could act together long enough to gain confidence and a sense of unity.

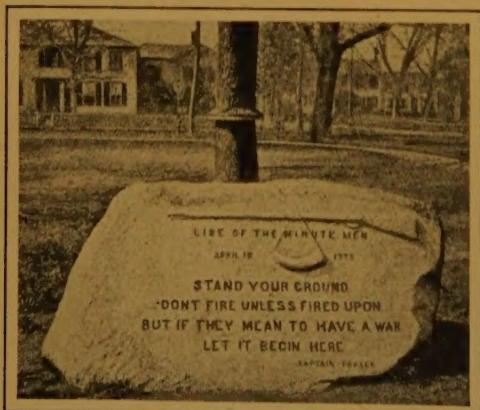
Army of the Revolution

The birth of the Army of the United States was in June, 1775. The germ was a force of colonial militia, founded by the Massachusetts Congress and commonly called "The Minute Men." They and the rest of the militia of the New England States were besieging the British



FIGHTING IN COLONIAL TIMES

The battle of Lake George, September 8, 1755. From painting by F. C. Yohn



THE LINE OF THE MINUTE MEN

Showing where they stood on Lexington Common and made the first fight for liberty

THE STORY OF THE AMERICAN ARMY

in Boston when, June 14, 1775, Congress authorized the raising of national riflemen. The next day Congress appointed Colonel George Washington of Virginia Commander-in-chief of the "Continental" forces. The first meeting of an American army with its Commander-in-chief was on Cambridge Common, July 3, 1775, under or near the famous Washington Elm.

From the beginning, this army was made up of two elements, the regulars and the militia, both of good material, strong, vigorous, self-reliant men. The organization was far inferior to the material. Both forces were enlisted for short terms, which frequently paralyzed the war

by the fading away of the troops; and caused immense extra expense for recruitment, bounties, transportation and pay. Notwithstanding money bounties and the promise of lands, the Continental Army, in January, 1777, sank below 1,000; at the end of the war it was about 13,000. The total number of regular enlistments during the war was 230,000, which, however, includes scores of thousands of reënlistments. It was reinforced every year by drafts of militia serving for short terms—two to six months, with a result which is measured in Washington's frequent and plain spoken letters. Thus he wrote in 1776: "To place any dependence upon militia is assuredly resting upon a broken staff."

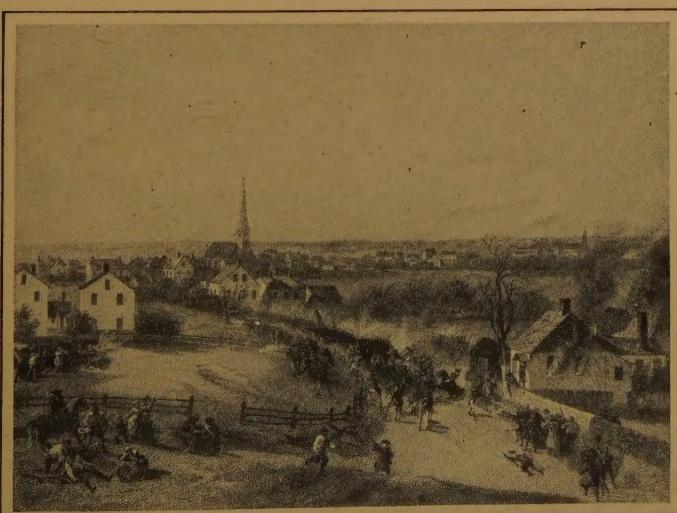
The militiamen were, he said, untrained, timid, homesick, undisciplined, short in service, jealous and expensive, and he protested against a short enlistment and a mistaken dependence on militia.

In 1777 the army reached its high-water mark of 35,000 regulars. This force, with the aid of 35,000 militia enlisted for short terms, held the British forces of probably 15,000, and made possible the capture of Burgoyne's



WASHINGTON ELM, CAMBRIDGE, MASS.

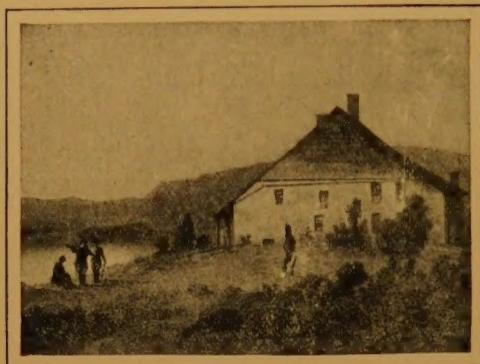
Inscription on the tablet: "Under this tree Washington first took command of the American Army, July 3, 1775"



RETREAT OF THE BRITISH FROM CONCORD

Engagement of April 19, 1775. English army harassed by the raw, untrained men of the Colonies. From painting by Chappell

THE STORY OF THE AMERICAN ARMY



WASHINGTON'S HEADQUARTERS AT NEWBURGH
The old "Hasbrouck House" as it looked in 1783, when
Washington occupied it

After all, the wonder is not that the American army was weak or unskillful, but that, with all those defects, it beat the British. Almost all the American officers got their only military training in that army. The raw troops, with green officers, did somehow hold out against veteran British forces under trained officers. The American army was never so beaten in a pitched battle as to break up into fragments that could not reunite.

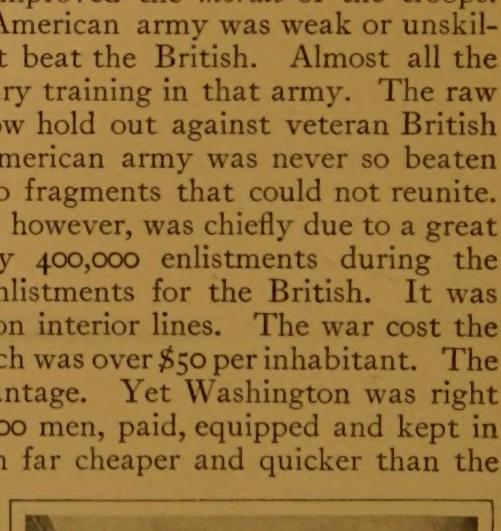
The success of the American army, however, was chiefly due to a great superiority in total numbers—nearly 400,000 enlistments during the Revolution, against about 150,000 enlistments for the British. It was also fighting in its own country and on interior lines. The war cost the United States about \$200,000,000, which was over \$50 per inhabitant. The pluck of the troops was a great advantage. Yet Washington was right in saying that a regular army of 50,000 men, paid, equipped and kept in service all the time, would have been far cheaper and quicker than the confused system of regulars plus militia, with the short terms of service.

The Early Federal Army

The main result of the Revolutionary War in the minds of the American people was an undue confidence in their own ability to improvise an army. Moreover, Congress was unable to pay its soldiers. Hence the regular army was allowed to drop, till at one time it came down to the eighty men of the Hamilton Battery. For the protection of the frontier, Congress went back to the militia; then in 1785 it provided for 700 regulars.

invading force. From that time on, the American army declined in numbers and the British rose, till, in 1781, they had 42,000 against 13,000 Continentals and 16,000 militia. Hence nothing but the aid of the French troops made possible the capture of the army of Cornwallis and the consequent victory of the Americans.

The foreign officers found the American armies crude, and their system of supply wasteful and inefficient; but Baron Steuben reorganized the system of drill and much improved the *morale* of the troops.



THE LONG ROOM, FRAUNCES' TAVERN, N. Y.
In this room Washington bade farewell to the officers of the Continental Army on Dec. 4, 1783. Fraunces' Tavern still stands at the corner of Pearl and Broad Streets, New York, and is kept as a memorial

THE STORY OF THE AMERICAN ARMY



VARIOUS TYPES OF SOLDIERS AT THE BEGINNING OF THE REVOLUTION

From Left to Right—"Minute Man," Virginia Rifleman, Maryland Rifleman, (in fur cap), New York Rifleman, City Cavalryman of Philadelphia, "Light Horse," Governor's Foot Guard of Connecticut, Continental Private of Pennsylvania, In the back the "Pine Tree" Flag of Bunker Hill, and the first "Union Flag," made of the British Jack and thirteen stripes for the Colonies.

The Federal Constitution of 1787 provided for a national army and also for State militia regiments. The new regular army, authorized in 1790, was to consist of 1,216 men, privates to receive \$3.00 per month. The mixed system broke down in the first frontier war in 1791, when St. Clair's force of regulars and militia was ignominiously beaten by the Indians. According to a committee of the House of Representatives, "the militia appeared to have been composed principally of substitutes, and totally ungovernable and regardless of military duty and subordination."

In 1798, when war with France seemed approaching, Congress authorized 10,000 new regulars, but coupled with it the old provision for volunteers to serve not more than three months. Under Jefferson the army was allowed to sink to about 1,200 men, but the tide began to rise when, in 1802, the United States Military Academy at West Point was founded. Nevertheless, in 1812 less than 7,000 regulars were under arms.

When the War of 1812 broke out, the regular army was enlarged, but at the same time 100,000 militia were called. The war was a lesson in unfitness. The British, with less than 2,000 regulars and perhaps 20,000 Canadian militia, held their frontier in 1812 against 15,000 regulars and about 50,000 militia actually called into the service of the United States.

THE STORY OF THE AMERICAN ARMY

In 1813 the United States had 150,000 troops, and was everywhere beaten in land fights. In 1814, 3,600 Britons marched on Washington, and the weak administration of Secretary Armstrong waited till the last moment, and then was able to summon only 400 regulars, 600 marines and 4,400 militia—a force which was completely routed by the British, leaving the national Capital open to them.

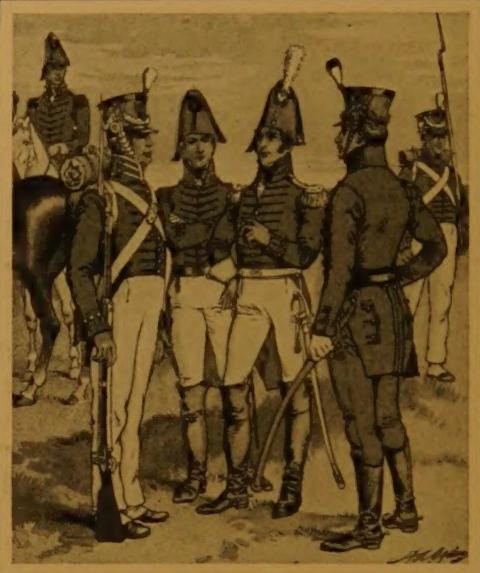
In several battles, however—at the Thames, at the Baltimore forts, at the defense of Plattsburg, and at the successful defensive battle of New Orleans—the American troops showed that under strong, capable commanders, they could stand against experienced enemies; that the fault was not in the men, but in the system.

Out of the war came also a few officers such as Winfield Scott and Andrew Jackson, who had military genius, and were great fighters; who could rally men around them, and knew how to give a fair chance to the soldier.

The Army of the Frontier

The present regular army of the United States really dates from 1815, when it was reorganized and began a series of little Indian wars that lasted for sixty years. Still, the military organization was loose and defective.

In times of crisis, instead of increasing the regular force to the needed strength, Congress always insisted on calling in militia, and in 1821 reduced the regulars to 6,000, notwithstanding the threatening Indian situation on the southwestern frontier. An incident of the irregularity of the times was General Andrew Jackson's raising 2,500 militia in 1819, appointing 230 officers, and mustering them all into the service of the United States without any specific authority from the Government. With this force Jackson then invaded the Spanish territory of Florida, against the wish of the President.



MEN OF 1812

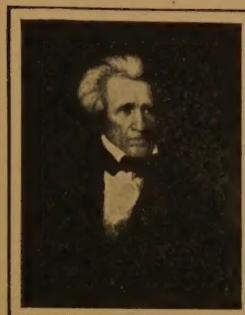
From left to right; Staff Officer (on horse), Infantry Private, Two Infantry Officers and Artillery Officer (holding sword)



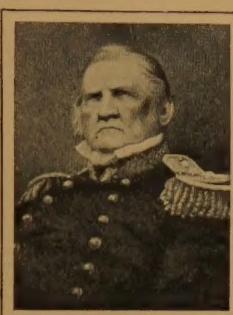
MEN OF 1848

Officers and soldiers of the Mexican War

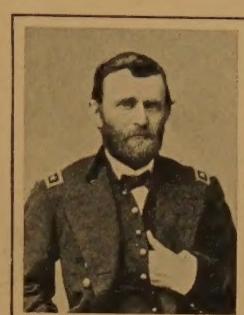
THE STORY OF THE AMERICAN ARMY



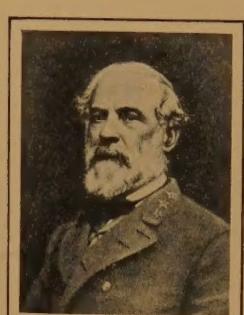
JACKSON



SCOTT



GRANT



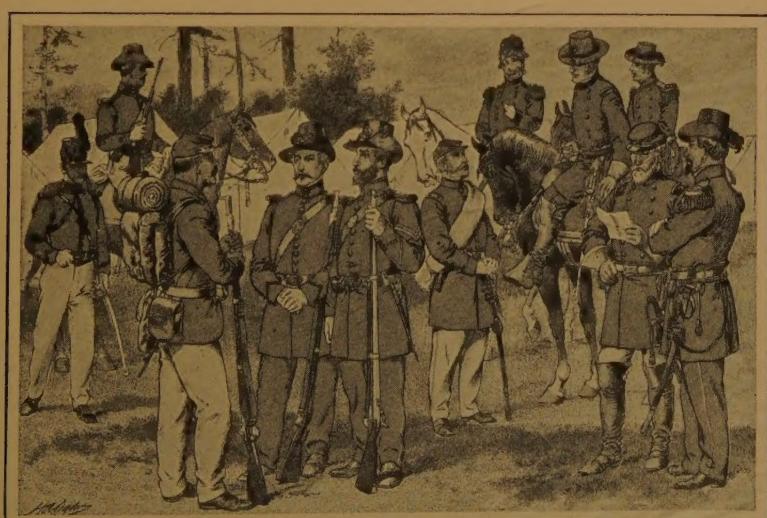
LEE

Great Army Leaders of three wars. Andrew Jackson, the iron-hearted leader of the War of 1812. Winfield Scott, whose life spanned three wars, an officer in 1812, the hero of the Mexican War in 1848, and a retired general of the Civil War. Grant and Lee, the great opposing military commanders of the Civil War.

The so-called Black Hawk War of 1832, in which six white men were killed and twelve wounded, was fought by 1,300 regulars and 4,600 volunteers, among whom was Captain Abraham Lincoln of Illinois. When the Seminoles rose in 1835, the United States was not able to detach enough regular troops to hold the 1,300 Indian and negro fighting men; and 26,000 militia in addition could not end the war. First and last, 60,000 men were called into service in this war against a handful of Indians.

The first real war that the army was called upon to fight was with Mexico in 1846, and amazing results were reached with small forces. General Taylor's "Army of Occupation" consisted of 3,500 men, with whom he fought the two victorious battles of Palo Alto and Resaca. The regular army was then raised to 35,000 and did most of the work of the war, though some of the 74,000 volunteers fought well.

The States, as in previous times, were allowed to appoint the officers of the volunteers, which greatly interfered with discipline and efficiency. However, the supreme command was given to two experienced soldiers, Zachary Taylor and Winfield Scott. The war was also a nursery for recent



REGULAR ARMY MEN OF THE CIVIL WAR

From left to right: Privates of Artillery and Cavalry; Infantry Private talking to Private of Heavy Artillery and Corporal of Infantry, both in full dress; Infantry Captain, Brigadier General and Artillery Colonel (all on foot); Major General and Aide (on horseback).

THE STORY OF THE AMERICAN ARMY



CAVALRY TRAINING AT FORT MYER, VA.

graduates of West Point, of whom U. S. Grant, W. T. Sherman, Robert E. Lee, and many others were to use their Mexican experience in the Civil War of 1861-65.

The Mexican War was a brilliant success: and the Mexicans were obliged to cede New Mexico and California to the United States. Only about a sixth of the 74,000 volunteers were militia, which was a proof that the old system of trying to train men through the States was breaking down. During the next twelve years the principal service of the army was occupying the newly annexed territory, including the brief Mormon War of 1858.

The Army During the Civil War

Out of the 16,400 men and officers enrolled in the army at the outbreak of the Civil War, 15,000 were at distant Western points, and the remaining 1,400 were scattered through the East, from Canada to the Gulf of Mexico.

Soon after the firing on Fort Sumter, in April, 1861, President Lincoln, without waiting for the consent of Congress, authorized an addition of 23,000 men to the regular army. Meanwhile he had been obliged, for the protection of Washington, to fall back on the State militia; and he called at once for 75,000 of them to serve three months. A few weeks later he asked for 43,000 "volunteers." These might easily have been attracted to the regular army; but Congress accepted the policy of organizing the volunteers as State regiments, the officers to be appointed by the Governors. Thus the Government was committed to the policy of a mixed army of three different kinds of soldiers. At first they were clad in a variety of high colored uniforms; later they settled down to the sober blue and gray.

With the exception of four or five thousand men, none of the militia or volunteers or newly enlisted regulars had any previous military training; and throughout the war both sides depended upon soldiers who had to be equipped, disciplined and trained after they enlisted. Instead of

THE STORY OF THE AMERICAN ARMY

distributing a large part of the able regular officers into the new regiments, the governors appointed civilians, who had to get their training by hard knocks, at the expense of the efficiency of the army.

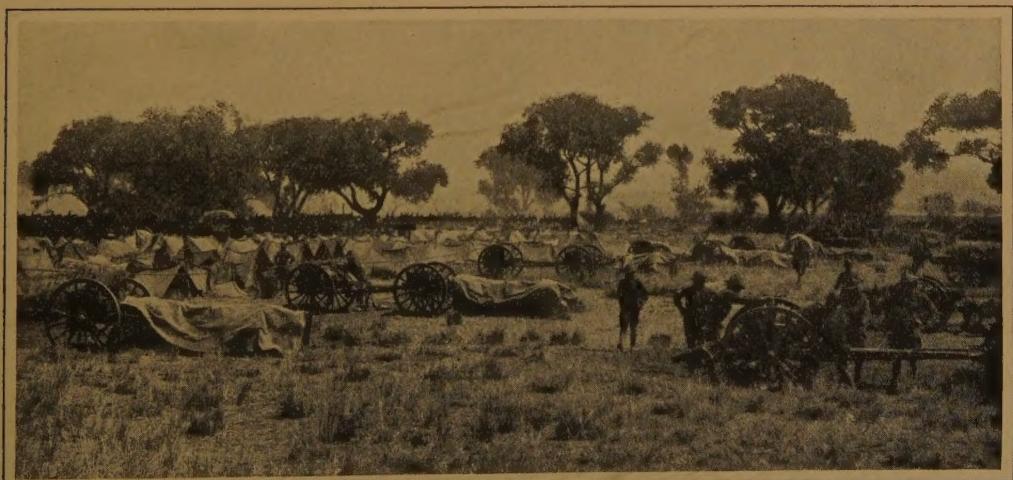
The regular federal troops were eventually recruited up to 67,000 men, but they were submerged in the vast federal army that was raised. This army, which in the larger sense was composed of all persons actually in the military service of the United States, rose in 1864 to about a million men. The total enlisted persons during the war were about two millions, of whom one million reënlisted at least once.

Hundreds of thousands of these men became professional soldiers through the experience of campaigning; and at the end of the war they were as good troops as the world sees. To keep them in the service, however, was a difficult task. The original motive of patriotism flagged, and had to be reinforced by money bounties, rising eventually to \$1,200 per man, by the payment of substitutes, by promise of pensions for disability.

All these efforts proved insufficient; and in 1863 the Government, for the first time since the Revolution, ordered a draft, which was another name for conscription by lot. This method led to a riot in New York City, in which a thousand people were killed. The threat of the draft nerved many States up to filling their quotas; but the actual number of men directly obtained by this method was not over 15,000. Military



Copyright, Underwood & Underwood
FIGHTING IN THE PHILIPPINES
Infantry advancing on Malolos



Copyright, Underwood & Underwood

SIXTH FIELD ARTILLERY IN CAMP (1916)

THE STORY OF THE AMERICAN ARMY

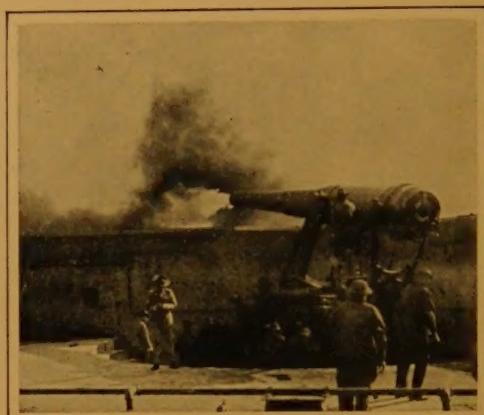
experts have shown how costly and how wasteful of human lives were these methods of recruiting and maintaining the armies; nevertheless, just as in the Revolution, these originally raw troops managed to fight the war through.

The Confederacy was much more successful than the Union Government in bringing the able bodied men into the service; but since the field laborers were slaves and could not be enlisted, the South could raise only about 1,100,000 or 1,200,000 men during the whole war, which was a much larger proportion of the white men than on the Northern side. Here again, if either side had raised a force of regulars at the beginning, enlisted them for the war, and carefully trained and armed them under experienced officers, that disciplined army could have broken up the levies of militia and volunteers before they became hardened and disciplined soldiers.

The Army of the Last Fifty Years

The immense citizen armies speedily dissolved and returned to civil life. Neither North nor South felt much interest in the regular army, which was cut down gradually to 25,000 men, at which figure it stood till 1898. That was hardly sufficient for the long and difficult task of dealing with the Indians, who were roused to war by the steady pressure of the frontiersmen and by the building of the Pacific railroads through their hunting grounds. The army, officered by former soldiers of the Civil War, fought many hard little campaigns with the Sioux and the Apaches and the Modocs, in which military science, unlimited supplies, and the personal bravery of the troops, always brought victory in the end. The one great tragic event was the entrapping and massacre of General Custer and his command by the Sioux Indians under Sitting Bull in Little Big Horn Valley in 1876.

To this use of the army in Indian campaigning was added a tedious guard duty of the government forts and posts, with an occasional call to suppress a riot, when the police and State militia had failed; for though we do not stop to realize it, Uncle Sam's boys have for years been the final protection of organized society against disorder. The reliance on this national police force accustomed the country to seeing it distributed all over the land in small detachments. People lost the consciousness that an army is intended to fight in the largest possible groups; and that ability to handle a regiment against the Indians did not prepare a commander for directing an army corps of 25,000 men in a great campaign—still less for the direction of armies of millions.



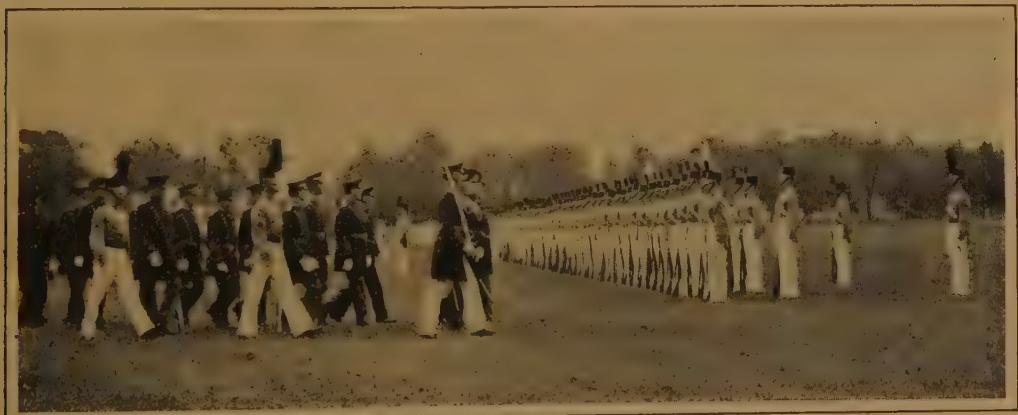
Copyright, Underwood & Underwood
COAST DEFENSE GUN, FORT WRIGHT, WASH.

THE STORY OF THE AMERICAN ARMY

The next opportunity for grand scale warfare came when war broke out with Spain in 1898. The regular army was enlarged to about 100,000; 250,000 militia and volunteers were also called out. Fortunately, a few thousand men proved able to conquer Cuba and the Philippines. Hence the citizen army could be disbanded before it had been fairly formed. This war is the first in our history, except Scott's campaign in Mexico, in which the army was carried over seas and land into an enemy's country.

The new responsibilities of the Government in the Pacific, the Caribbean and the Isthmus of Panama compelled the Government, for the first time, to keep up a considerable army in time of peace. The regular army stood at about 65,000 men until the outbreak of the Great War in 1914. The difficulty experienced in sending Pershing's force of 15,000 men down into Mexico again called public attention to the need of a larger army and a better organization of transport and supply; and the regular force in 1915 was raised to about 106,000.

The present American army is very different from its forerunners. The uniform has passed from the old array of blue to the neutral khaki. The War Department has many plans for the improvement of the service. A War College has been set up in Washington for the training of officers; a General Staff has been organized; an aviation corps has been created. Field practice manoeuvres have been introduced; practice schools for civilians have been set up at Plattsburg and elsewhere; and the number of cadets at West Point has been increased. The war with Germany in 1917 caused war problems of the greatest importance for the American Army.



DRESS PARADE AT WEST POINT

SUPPLEMENTARY READING

THE STORY OF OUR FLAG. A beautiful illustrated booklet, printed in colors. Written by *Francis Scott Key*, third grandson of the author of "The Star Spangled Banner." Price, twenty-five cents.

THE STORY OF OUR ARMY By *Willis J. Abbot* Two volumes, illustrated.

OUR MILITARY HISTORY. Its Facts and Fallacies. By *Maj. Gen. Leonard Wood*.

* * * There are many books on the subject of the Army. Information concerning them may be had on application to the Editor of The Mentor.

THE OPEN LETTER

For a long time there seemed to be no reason why America should be drawn into war. Now, however, as we review the events of the past two years, it seems to have been inevitable. When houses all about are burning, and sparks are landing fast upon the roof, can anyone long maintain the position that he will have "nothing to do with the fire?" Sooner or later he must turn to and help put it out.

* * *

The situation is significant and enlightening in its revelation of the character of the American people. It was only a short time ago when the national expression was overwhelmingly strong for peace—even for non-resistance. Today the voice of war prevails and the land resounds with the call to arms.

* * *

The notes sounded in public utterances are: Humanity, Liberty, Civilization and World Democracy. Beneath, however, I think lies a burning sense of injury to the Flag. The words "Humanity" and "Civilization," thrown on a screen in public assemblies, arouse applause; but the flag fluttering in the air is greeted with an uproar of enthusiasm. It is wrong to say that any of the people *want* to go to war. I do not believe that *anyone* wants to go to war. Taking up arms is an act of supreme sacrifice and service to Humanity—and especially to the Flag.

* * *

The smell of the bunting is in the air. I know well the meaning of that. When I was a boy I carried a flag in a

Fourth of July parade. The flag was too big for me, and, as it waved, it half enveloped me. That hour was rich in emotion. There was not only the pride of being a standard bearer, but, as the folds of the flag blew about my face, I breathed in the very smell of the bunting. It got into my blood. I grew to know the Flag by its colors, by its vital folds as they unfurled in the winds, and by the actual odor of the bunting.

* * *

"A thoughtful mind," said Henry Ward Beecher, "when it sees a nation's flag, sees not only the flag, but the nation itself. He reads in the flag the history and principles that belong to the nation.

When the French Tri-color rolls out to the wind, we see France. When the Italian flag is unfurled we see Italy. When the united crosses of St. Andrew and St. George set forth the banner of old England we see not the cloth merely; there rises up before the mind the noble aspect of that monarchy which has advanced its banner for liberty, law and national prosperity.

* * *

Today our Flag is calling; and as we turn our eyes to it at this critical time we realize that when we speak of dedicating ourselves to the service of Humanity we do so

in the name of the Flag, for it stands for all that is noblest and best in Humanity. Under its colors Humanity has been freed; it has carried Humanity and Civilization to other lands; and within its folds the soul of Humanity abides.



MAJ. GEN. HUGH L. SCOTT
Chief of General Staff,
U. S. Army



THE FLAG AND THE GUNS
From a photograph taken at Fort Myer, Va.

W. D. Moffat
EDITOR



THE great Lick Observatory, illustrated in the present number, is an excellent example of the modern large research observatory. Indeed, the problem of designing and locating an astronomical observatory has become almost an entirely new problem during the last quarter-century. Earlier observatories were usually placed

simply beside the house where some college professor of astronomy happened to live. Almost all astronomers made their living by teaching the elements of their science to young college students, and only their spare time could be given to actual study of their science. Expanding the boundaries of our knowledge of this universe thus became an avocation rather than a serious life-work.

But with the founding of the Lick Observatory this was changed. James Lick was a Californian miner, who wanted to devote his considerable fortune to the erection of a monument which would make his name long remembered by his fellow-citizens, and which would at the same time be of real value in the future. He was fortunate in deciding on an observatory: his body rests quietly under the foundation of his great telescope; nor has any one of the world's heroes a nobler monument.

The Lick Observatory, thus founded, was made part of the University of California; but the purpose of the observatory was research from the very beginning, not elementary instruction. Therefore, the Lick trustees began their task by causing a careful search for a location ideally adapted to their purpose. They proposed to put the telescope where it could do its work best, and then move the astronomer to the telescope instead of the telescope to the astronomer.

After many experiments involving the use of an actual telescope in various places, it was finally decided to put the big instrument on a mountain top, and Mt. Hamilton was selected as the most suit-

able peak. The reason for thus choosing a very high elevation is a simple one. The great foe of successful astronomic observation is our earth's atmosphere. The earth is surrounded by a shell of air, and through this air the astronomer must necessarily make his observations. But the air is always contaminated with dust, water vapor, and even smoke. These imperfections of the atmosphere are magnified, as it were, by the great power of the telescope, and they diminish materially the excellence of telescopic vision. But by placing our glass on a mountain we obtain much the same advantage as would result from making the tube long enough to reach outward quite through our atmospheric shell, if this were possible.

On the whole, later extended experiences have not fully proved that the mountain location is really the best. Some astronomers now think a situation in a great flat arid plain is superior. The Lowell observatory at Flagstaff, Arizona, was so located, and the astronomers there are convinced their "seeing" is the best in the world. On the other hand, the observatory founded a few years ago by the Carnegie Institution was again located on a mountain.

While the question of the most favorable observatory location is thus still an open one, there is now substantial agreement among the best authorities that the observatory must be dissociated from the teaching of elementary astronomy, and must be manned with astronomers who can give their undivided attention to observation, and to the study of their science.



YERKES TELESCOPE, IN YERKES OBSERVATORY, WILLIAMS BAY, WISCONSIN

THE great telescope of the Yerkes Observatory belongs to the University of Chicago, but is located at Williams Bay, in the State of Wisconsin. Large telescopes intended for research work cannot well be placed in a big city with any hope of successful results, because the air in all great cities is always so heavily charged

with smoke that it is impossible to secure "good seeing," which is the astronomic name for favorable observational conditions.

This telescope has the biggest lens so far constructed, and the apparatus as a whole is a finely perfected piece of machinery. The tube is of steel, about sixty feet long; the foundations, the dome, and all other parts are of course large in proportion.

As in the case of all astronomic telescopes, the tube is fastened to a pair of pivots or "axes" at right angles to each other. The telescope tube turns around the first axis, and this, carrying the tube with it, itself turns around the second axis. This combination gives, in effect, a universal joint, and makes it possible to aim the tube at any point in the heavens. The actual turning of the tube around the two axes is accomplished with motors, the astronomer having merely to press the proper electric button, to set the great instrument in motion.

The axes also carry certain brass circles, upon which are engraved "divisions," or degrees. By means of these the astronomer can ascertain the location of the point on the sky toward which the telescope is directed; and he designates that point in much the same way as navigators designate the location of a ship at sea by means of latitude and longitude. If, for instance, a new comet or minor planet has been discovered, it is possible to notify all observatories at once by telegraph, and each astronomer will know ex-

actly where to look in order to observe the new object.

While the new comet is being observed it will always move perceptibly upward or downward in the sky; for all the heavenly bodies have constantly either a rising or a setting motion. This motion is counteracted by means of an immense clock, of which, as it were, the telescope is the minute hand; and thus the comet is maintained within the field of view quite automatically.

There is also an ingenious contrivance to overcome another difficulty caused by the great size of the instrument. If the comet is near the horizon, the tube, when in use, will be nearly in a horizontal position; but when the comet rises near the zenith the tube will be upright. This makes a vertical difference of thirty feet in the position of the eye-end of the telescope; and a corresponding difference of thirty feet in the position of the observer. It would be dangerous to have him climb so high a ladder; and so the whole floor of the observatory is made like an elevator. By means of motors it can be lifted and lowered, so as to bring the observer to the exact position required for his convenience while using the telescope. The big stand supporting the telescope itself goes down through a hole in the elevating floor, and rests on an absolutely solid masonry foundation below. In this way the stand and the telescope escape even the smallest vibration while the observer is being carried up and down by the elevating floor.



THE most beautiful object in the sky to the possessor of even a small telescope is the ringed planet, the unique planet, Saturn. Those who have been lucky enough to see it through a glass of some power can never forget it. A brilliant spherical ball, surrounded by a thin disc-like ring, seemingly of oval shape.

The ball can be clearly seen to pass through the ring, appearing both above it and below it.

Such an observation of Saturn carries us back in imagination to the days when astronomy was almost in its infancy: to those wonderful days and nights of the year 1610, when the first telescope was turned to the heavens, when every observation was a revelation, when a single moment would reveal discoveries such as a lifetime of devoted study would not now make known.

And it was Galileo who had that telescope in his hands. No mere star-gazer was he, but a keen and penetrating intellect, able to use his newly invented engine of observation to the very best advantage for the advancement of his best-beloved science.

And yet the mystery of Saturn first puzzled him, and finally baffled him. He described what he saw as a couple of handles attached to the planet, nor could he divine the purpose of those handles. Still more difficult to understand was the later complete disappearance of the handles, which observation Galileo also made. He gave up the problem and turned his attention to other things.

Of course we now know the reason of these strange occurrences. The ring is really an immense assemblage of small satellites, circling around Saturn in orbits that all lie nearly in the equator plane of the planet. So numerous are they, and so intertwined are their orbits, that we cannot at this distance see between them, and so they look to us like a thin flat ring.

But the earth is never placed in such a position that we can look squarely down on the ring. We see it distorted into an oval, as we would a cart-wheel seen nearly edgewise. Sometimes we even see the ring quite edgewise, and then it looks like a very thin luminous line, and is visible in very large telescopes only. This thin line phase was the occasion of the complete disappearance recorded by Galileo, for his little telescope was by no means powerful enough to render it visible.

It was half a century after Galileo's observation when Huygens first explained the ring to be a ring. But he dared not at first publish his result, fearing it might be erroneous in some way, for it was quite unique and without precedent. He finally hit upon a method of publication which is worth remembering, for it is as odd as his explanation itself. He wrote a sentence in Latin, announcing the discovery, and then mixed up all the letters of the sentence quite without order. He then published this mixture of letters as a sort of puzzle, which, of course, no one could solve. Huygens' idea was to secure for himself the honor of the discovery; for if any other astronomer should also find the solution of the problem, Huygens would always be able to prove that he had accomplished this first, by simply publishing the solution of his previously announced puzzle. But if, on the other hand, his explanation should later prove to be incorrect, he need never explain the puzzle, and thus he would escape the blame that always attaches to any man of science who commits a serious blunder.



JUPITER is the giant planet of the solar system, the largest body in it after the sun itself. It has four bright moons that may be seen with a small telescope, and several additional fainter moons that require very great optical power to render them visible. But the four large moons were within the reach of Galileo's telescope,

which, as we have seen, was the first astronomic glass ever constructed. With this glass Galileo of course found the four historic moons the very first time he examined Jupiter, in the year 1610.

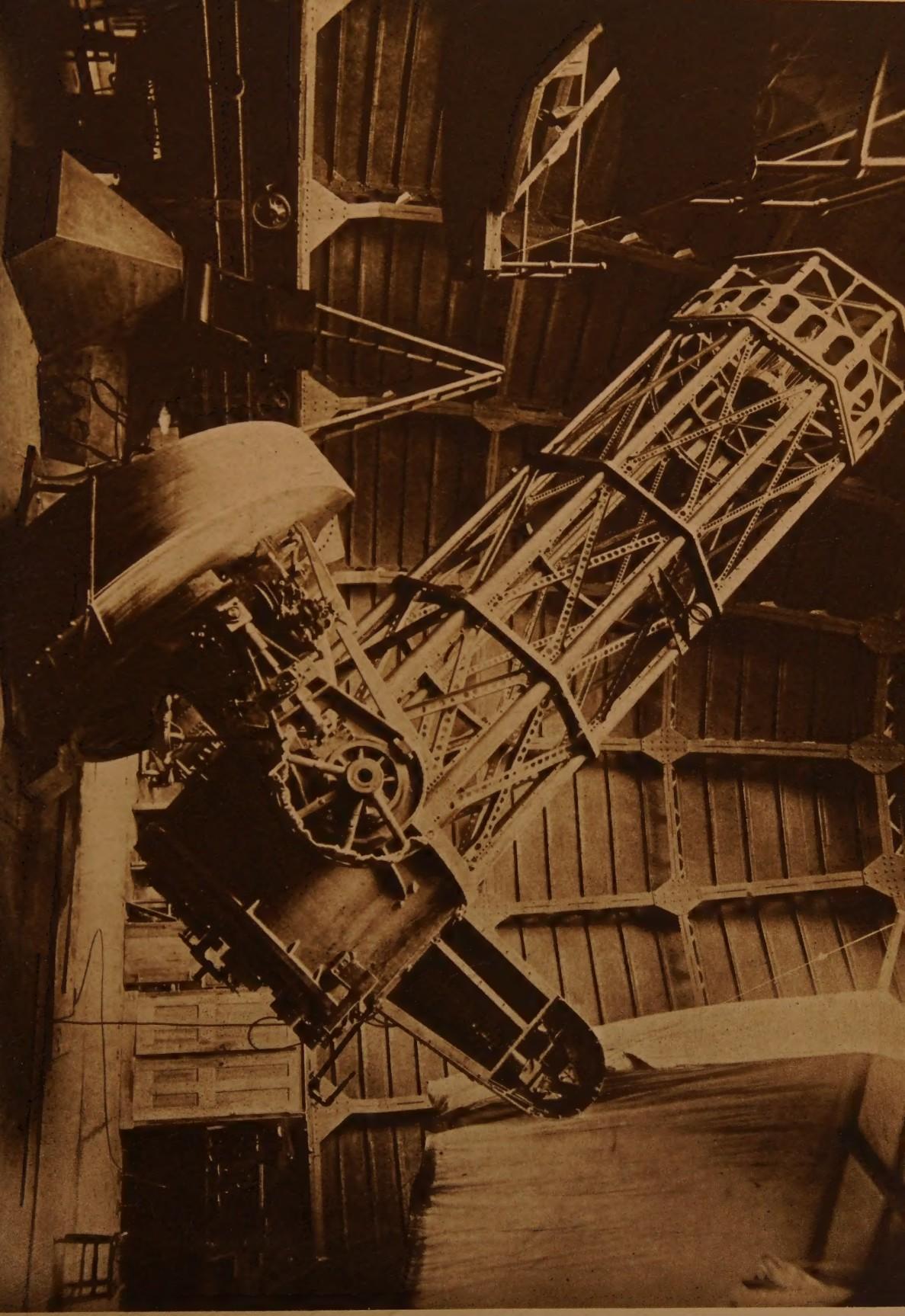
Galileo at first thought the moons were small stars in the background of the sky; but within a few days he detected distinct orbital motions of all the moons around Jupiter. This observation, in the mind of Galileo, gave a death-blow to the old Ptolemaic theory of the universe, which considered the earth to be immobile at the center of the solar system. Jupiter and its moons seemed to Galileo like a miniature sun with its attendant system of planets; and with this miniature solar system now plainly in view, Galileo felt that the newer ideas concerning planetary motion around the sun would surely prevail. And prevail they did.

These satellites or moons of Jupiter present very curious phenomena in the telescope. They may be eclipsed from observers on the earth in two different ways. They may pass behind Jupiter itself, and then the interposed planet will render them invisible; or, they may attain such a position that Jupiter will be interposed between them and the sun. The sunlight being thus cut off from them, the satellites will fail to be illumined, and

will consequently also be invisible to us.

Sometimes a satellite will pass between us and Jupiter. Being then projected or seen against the bright surface of the planet, instead of the lightless background of the sky, the satellite will generally become invisible, just as if it were eclipsed. Still at other times, a satellite happening to pass between Jupiter and the sun, will throw its own shadow on the planet. This shadow then looks like a small, round, black dot on the bright disc of the planet; and it moves slowly across the disc as the satellite moves in its orbit.

The exact times when these various satellite phenomena occur can of course be predicted with accuracy. Such predictions are made each year, and published in the official government almanac, called the "American Ephemeris." By observing such phenomena with a small telescope it is possible to compare the local time when they are seen to occur with the predicted Washington time, and thus obtain quite a good determination of the time-difference between one's own home and the city of Washington. From this time-difference it is then possible to calculate one's terrestrial longitude from Washington, since fifteen degrees of longitude always correspond exactly to one hour of time-difference.



THIS planet is in one respect the most interesting of all our neighbor planets, for it is the one suspected of being inhabited by people more or less like ourselves. It cannot be said that the existence of such "Martians" has been proved, or even rendered very probable, but it may be admitted readily that if there is a second inhabited planet within the solar system, Mars is most likely to be that planet.

The main arguments in favor of the Martians are quite simple. In the first place, Mars is not so very much farther from the sun than is our earth, and so it may fairly be supposed to receive about as much solar light and heat as does the earth. The length of the Martian day, and the conditions determining the nature of the Martian summer and winter seasons are also not very unlike the corresponding conditions on the earth; so that, astronomically speaking, Martians, like ourselves, may be said to be at least astronomically possible.

It is also an undisputed fact that Mars shows certain well-defined bright patches near the Martian poles, and that they always increase in size in the Martian winter, and undergo a corresponding diminution in the Martian summer. These polar patches have always been supposed to be ice-caps, such as our earth also has at its poles, and such as would naturally exhibit the seasonal changes just mentioned.

With these facts before us, it is easy to imagine that the temperate regions of Mars are an arid desert, and that the inhabitants there are compelled to fetch water from the polar ice-caps in order to

preserve their life. But in addition to the foregoing, certain astronomers, notably the late Percival Lowell, have observed a network of fine lines on the planetary disc, connecting the polar and equatorial regions. These fine lines have been explained as a possible system of canals, intended to carry water from the poles to the equator.

It must be admitted that if these fine lines were so distinct that all astronomers could see them with their telescopes, they would certainly demand an explanation; and in that case the inhabitant theory would be a possible one. But most astronomers cannot see this network of lines, and even some of the most reliable observers, with the largest telescopes, have failed to verify their existence.

Under these circumstances, authorities are generally agreed that it is not now necessary to undertake an explanation of these supposed lines, nor will it become necessary unless their existence shall be rendered certain. In the meantime, however, there is of course no objection to speculative discussion of the subject; and there is no part of astronomical science better adapted to arousing and increasing popular interest in the heavens than this theory of Martian inhabitants.



MOON IN ITS FIRST QUARTER

THE earth has only one satellite, but it is a very large one. The diameter of our moon is about one-quarter as great as that of the earth, while all the other satellites in the solar system (as, for instance, those of Jupiter and Saturn) are but very tiny in comparison with the great planets around which their orbital motions take place.

Very careful telescopic studies of our moon have shown that its surface is covered with an immense number of mountains and craters; apparently what we see is distinctly of volcanic origin. But the surface of the moon is the surface of a dead planet. Whatever may have been the nature of the vast volcanic explosions that have occurred in the past, and that have left the lunar surface scarred and pitted as we see it, it is certain that no perceptible changes of any kind have occurred within the period of modern telescopic observation. So we are sure that no changes of any consequence have taken place within two centuries. It is safe to say that the moon has reached its final condition, and, while it lasts, will change no more.

The moon is a dead planet, without air and water. There can be no lunar atmosphere; a very simple observation makes this certain. As the moon progresses around the earth in its orbit, we can sometimes see it pass between us and a bright star. The star is then, of course, concealed temporarily from our view. It is "occulted," as astronomers say. Now when such an occultation is watched with a large telescope, we can observe the advancing moon gradually seem to approach the star, until at last, star and moon, as it were, are separated by only the slightest possible filament of sky. Then, suddenly, this too disappears, and the star is blotted out with startling suddenness. Now if there were a lunar atmosphere, this atmosphere would cover the star first, before the solid body of the

moon was interposed; and while covered by the atmosphere the star would be partially dimmed. In other words, the star would fade out gradually, as it sank behind the lunar atmosphere. And since this never occurs, astronomers are convinced that there is no air on the moon. And the absence of air means also absence of water; for if there were water in appreciable quantity some of it would assuredly evaporate and form an atmosphere with clouds.

The "phases" of the moon, its gradual change from a narrow sickle to the round full moon, constitute the most interesting lunar phenomenon observable by the unaided eye. These phases are due to the fact that the moon, like the planets, is not itself luminous, but shines only when illumined by sunlight. But the moon is a globe, or round ball. Therefore the sun must at all times illuminate one-half of the moon. And when observers on the earth look at the lunar globe, they must also at any moment see just one-half of it. But the half thus seen by us may not be the same half that is lighted by the sun. These two halves may overlap, or they may be mutually exclusive. If they overlap a little only, we see the crescent moon; or, in other words, we see only a small part of the illuminated half. If the overlap is larger, we see a greater phase. If the two halves actually coincide, we see all the lighted half, and we call it a full moon. And, finally, if the two halves are mutually exclusive, we see none of the lighted part, and then the moon is said to be in the new moon phase.